Maryland NIRT Highlight: *Nanotube Single Electron Memory*

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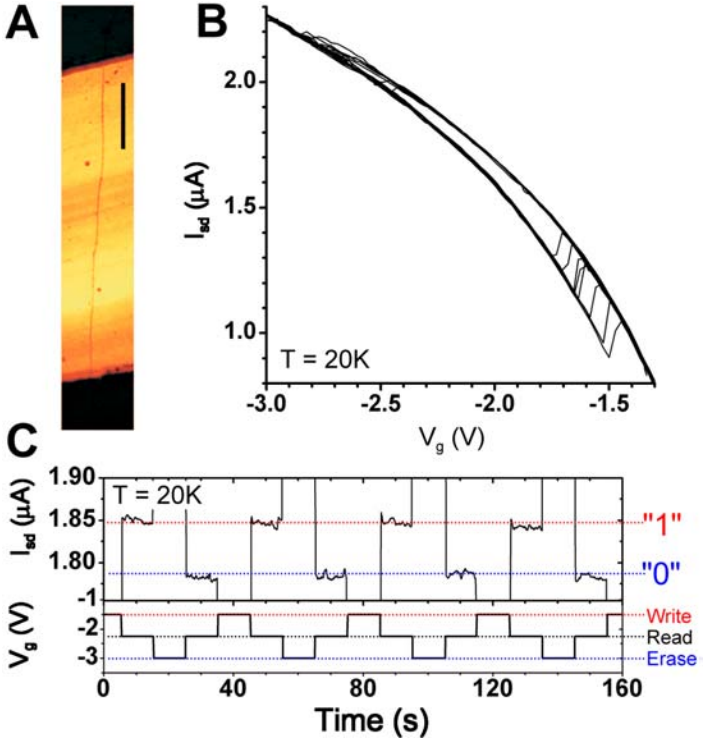
Nanoelectronics envisions assembling nanometer-sized electronic building blocks into useful electronic circuits using "self-assembly": guiding the blocks into place with, for example, chemical recognition. The Maryland NIRT aims to answer the question: What effects do the discreteness of atomic matter and electronic charge have on the operation of nanoelectronic devices?

The carbon nanotube is a model nanoelectronics building block – these nanometer-diameter wires of pure carbon may be metallic or semiconducting depending sensitively on their atomic structure. Researchers in the University of Maryland NIRT have recently shown that nanotubes are exquisitely sensitive to nearby charges[1]. This sensitivity may be a drawback, giving rise to increased electronic noise, or it may be a boon, enabling new types of devices such as memory elements or chemical sensors.

The researchers were able to demonstrate that carbon nanotube transistors may be used to form a memory cell, where the extreme charge sensitivity can be used to read out information stored as a single electronic charge[2]. Future work will study the effects of single-charge motion on the electronic noise in nanotubes, as well as exploring new methods for controlling and sensing single electronic charges.



Nanotube single-electron memory

An atomic force micrograph of the device is shown in (A); the nanotube is the thin, nearly vertical dark line; the dark blocks are the electrodes (scale bar 1 micron). The conducting silicon substrate beneath 500 nm of SiO_2 acts as the gate (not shown). The current I_{sd} as a function of gate voltage V_g is shown in (B). The gate voltage is swept back and forth eight times. The two branches of the curve correspond to a difference of one electron stored in the dielectric. Four read/write cycles of the memory are shown in (C).

1. P. L. McEuen, M. S. Fuhrer, H. Park, to appear in *IEEE Transactions on Nanotechnology* (2002).
2. M. S. Fuhrer, B. M. Kim, T. Dürkop, and T. Brintlinger, to be published.

Maryland NIRT Education and Outreach Activities

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Educational activities:

Currently 1 undergraduate, 4 grad students, and 1 post-doc receive training an interdisciplinary nanoscience including chemistry, physics, and materials science. Undergraduates and graduate students participate in a weekly journal club, and graduate students present their ongoing research to their peers once a semester.

The PI (left) demonstrates conservation of angular momentum to an elementary school student at the physics department's open house.

Graduate student (hand at upper left) works with two elementary school students in a (messy) outdoor activity involving the preparation of "silly putty" and experiments on its materials properties.

Outreach activities:

In addition to formal academic training and research training, our NIRT graduate students are also involved in public outreach activities, which are designed to provide them with life skills in communicating the excitement of scientific research to the general public. Each student participates in 20 hours per year of activities that involve one-on-one contact with K-12 students from the local school systems. The activities are organized and coordinated by the staff of the University of Maryland NSF MRSEC, who also provide the students with training in effective outreach skills.